TREFOILS IN HAWAII

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Introduction

Trefoils (*Lotus* spp.) are forage legumes of high quality (figure 1). They are also called birdsfoot trefoil and widely used in temperate and subtropical pastures because of their excellent palatability, high nutritive value, and ability to survive grazing. They do better than most legumes under soil conditions

FIGURE 1. A big trefoil.

generally considered unsuitable for most legumes. And although trefoils will grow on soils rather low in fertility, they will become established faster and produce more forage on fertile soils. They have been found to respond to phosphate fertilizer.

Another great asset is that they are known not to cause bloat in cattle. The pods that retain the small seeds are borne in a cluster resembling the toes of a bird's foot; hence the common name, birdsfoot, which is given to this group of legumes. The plants are self-sterile, so that pollination must be done by insects or other agencies.

Trefoils were first introduced to the Volcano District of Hawaii in 1916 by Mr. Herbert C. Shipman. They flourished well, and planting materials were distributed. Subsequently they were introduced to Parker Ranch by the late Mr. A. W. Carter, and to the Island of Molokai, where excellent stands were established in acid soil of pH 5.0, by the late Mr. James Munro. In recent years Mr. A. Hartwell Carter of Parker Ranch has taken a keen interest in trefoils and has developed some excellent stands.

In the last few years, trefoils have become popular in Hawaii because they are adapted to high rainfall areas with acid soils, as well as to alkali soils. It has been frequently noticed that trefoils have withstood and maintained themselves under more severe drought conditions than has white clover.

There is a well–recognized need for a forage legume with characteristics like that of trefoil to grow in a mixture with pangola which has become an important grass in the wet, low to middle elevation pastures.

In Hawaii, trefoil grows best above the 800-foot elevation, although it is found at elevations as low as 200 feet (figure 2).

FIGURE 2. Tony Freitas, foreman of Kahuku Ranch and T. Shirakawa, County Agent looking at a good mix stand of trefoil and pangola grass.

FIGURE 3. James W. Glover and Carl Sundquist examining big trefoil seedlings on Kahuku Ranch.

Mott, working at the Indiana Station, found that the addition of trefoil to the permanent pasture resulted in a significant increase in animal gains in five out of six years. In spite of continued heavy fertilization, the production from permanent pasture with no trefoil averaged slightly less for the last three years than for the first three years.

In contrast, pastures with trefoil averaged 22 percent more animal gain per season for the last three years than for the first three. This is in keeping with the often repeated statement that the trefoil is slow in establishing itself and in getting into full producion (figure 3). James W. Glover of Kahuku Ranch and Herbert C. Shipman of Puu Oo have, through experience, ascertained that it takes nearly two years to get a good stand of trefoil.

A study of big trefoil (*Lotus uliginosus*) with and without identical mixtures of grasses has shown that the legume, with grasses, increased the total yield from two to three times. Carl Sundquist, Soil Conservationist in Kau, Hawaii, found that a trefoil and grass mixture, compared with grass alone under similar treatment, produced about four times more forage that was about three times as nutritious, from a protein standpoint. He was also able to demonstrate that the phosphate uptake was much greater in the grass associated with the legume than in the grass when grown alone.

Classification

There are four species of birdsfoot trefoil in the Hawaiian ranges; two are short-lived (annual) and the other two are long-lived (perennial). Slender birdsfoot trefoil (*Lotus angustissimus*) and hairy birdsfoot trefoil (*L. hispidus*) are annual; broadleaf trefoil (*L. corniculatus*) and big trefoil (*L. uliginosus*) are perennial.

The following characters separate the species:

I. Plants annual
   - A. Flower 3/16-inch long, stem covered with whitish hairs–*L. angustissimus*.
   - B. Flower 3/8-inch long, stem covered with brown hairs–*L. hispidus*.

II. Plants perennial
   - A. Flowers 3 to 8 in a cluster, pods 3/4- to 1 1/4-inches–*L. corniculatus*.
   - B. Flowers 7 to 12 in a cluster, pods 1- to 1 1/2-inches long–*L. uliginosus*.

The two most widely distributed species are *Lotus corniculatus* and *L. uliginosus*. In the last few years, the big trefoil has become popular in Hawaii. It is planted with pangola grass because they are compatible (figure 4).

FIGURE 4. An excellent growth of big trefoil at 2600 ft. elevation, Kamuela, Hawaii.

FIGURE 5. Showing a long and strong taproot of broadleaf trefoil—S.C.S. photo, by Carl Sundquist.

BROADLEAF TREFOIL (*Lotus corniculatus*). There are many varieties of broadleaf trefoil growing in Hawaii. One of the varieties has been separated into a species called *Lotus tenuis* (narrowleaf trefoil) by some workers and as *Lotus corniculatus* var. *tenuifolius* by others. Tome and Johnson in 1945 studied the narrowleaf and the broadleaf trefoils and found that these two types should be classed as distinctly different species, *Lotus corniculatus* and *Lotus tenuis*.

In this treatment *Lotus corniculatus* and its varieties will be called broadleaf trefoil. There are some distinguishing differences between the narrowleaf trefoil and the broadleaf trefoil but due to the influence of climatic and soil factors, the growth forms often vary beyond separation. In general, the broadleaf trefoil grows upright and the individual leaflets are usually more than half as wide as they are long. The narrowleaf trefoil usually has prostrate stems, except when growing in a thick growth of grass and reaching for sunlight.

This circular, not meant to be a critical taxonomic treatment, combines all

the varieties of *L. corniculatus* under this species. The hairiness of the plants vary from smooth to pronouncedly hairy. The leaves vary from small and narrow to broadly-long, and also from egg-shaped or wedge-shaped to lance-shaped. The stems are several to numerous, spreading on the ground both in many directions in some cases to somewhat upright in others. Taproot is large, long and strong but the roots on the stems near the base of the crown are weak (figure 5).

BIG TREFOIL (*Lotus uliginosus*). The big trefoil often goes under the name of *Lotus major*. Like broadleaf trefoil, this species also has some varieties, and the variation is not distinct to any one variety. For example, the degree of hairiness varies from almost smooth to quite hairy.

The greatest difference of big trefoil from other *Lotus* species and their varieties is in the system of numerous underground stems, and the many roots which are produced from the nodes all along the stems. The shallow underground spreading rootstocks keep sending up new stems, and as a result, the stems generally stay productive (figure 6). This growth habit is an advantage because new plants can be established vegetatively.

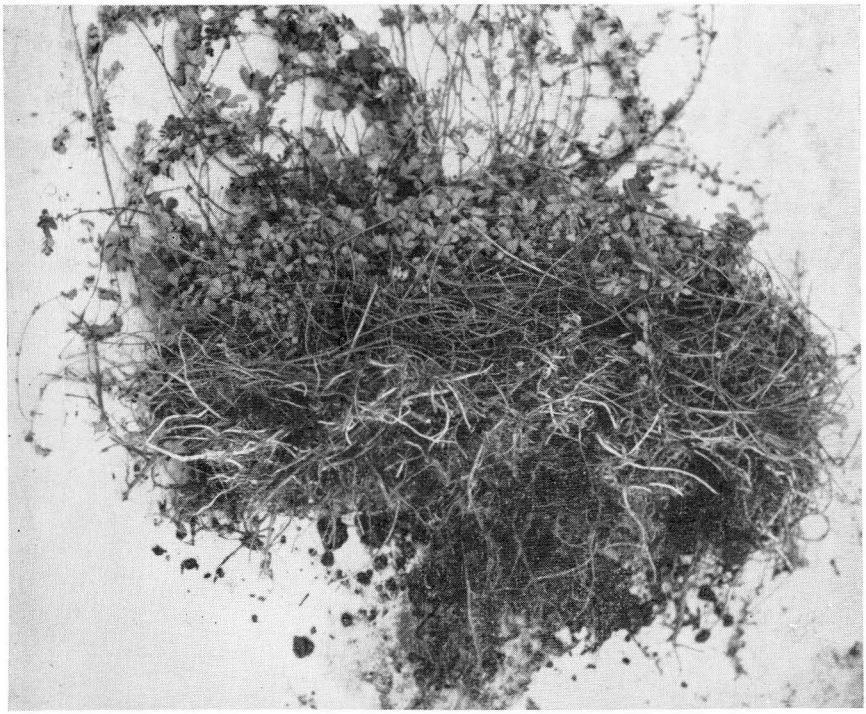

FIGURE 6. Showing surface and underground slender rootstocks of big trefoil—S.C.S. photo, by Carl Sundquist.

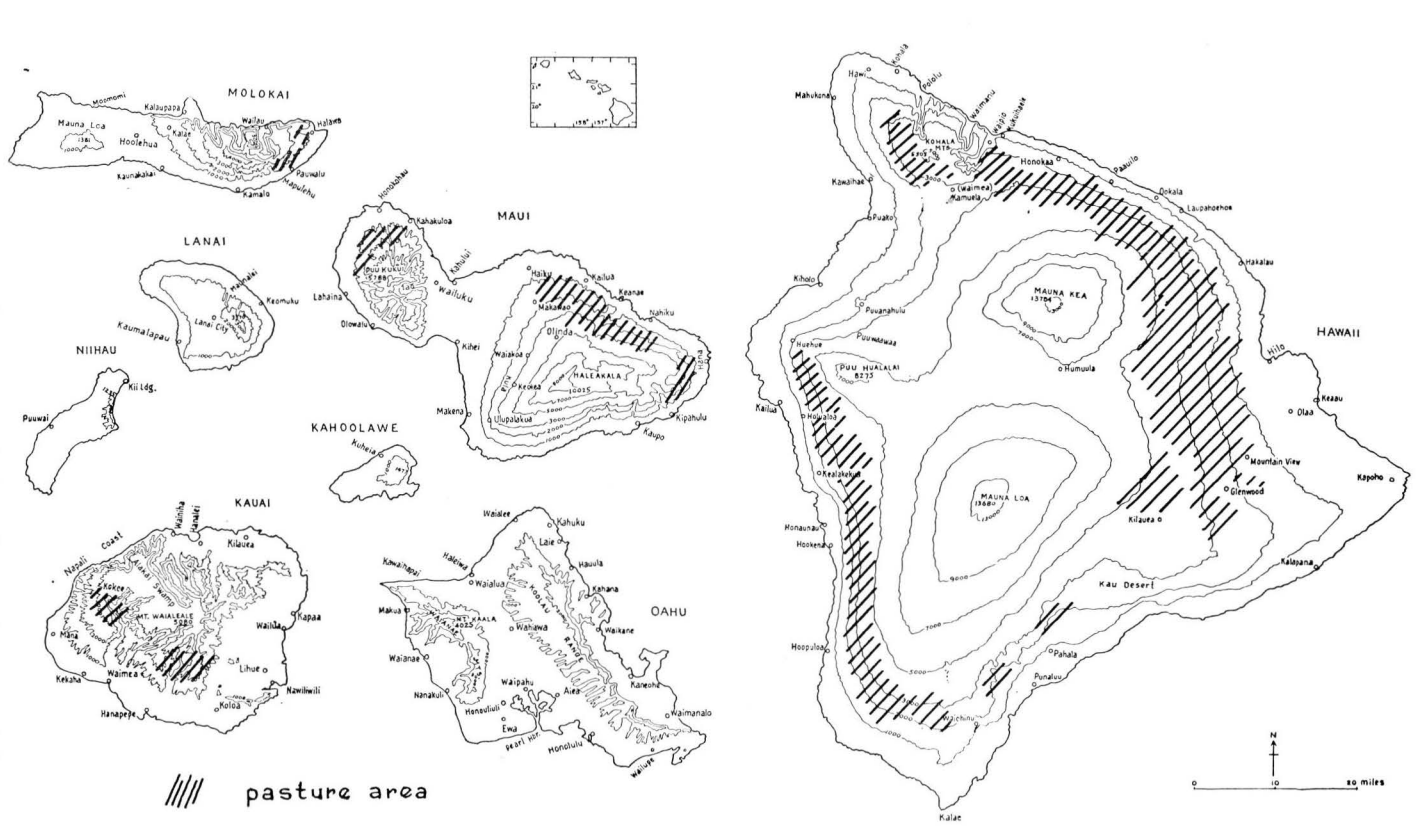

FIGURE 7. Pasture area where perennial (broadleaf and big) trefoils are found to be adapted.

Big trefoil is a true sod former. It is adapted to wet, poorly drained soils and highly tolerant to acid soils. It has 7 to 12 yellow flowers in a cluster, and averages about a million seeds per pound, as compared with approximately 375,000 seeds per pound for the broadleaf trefoil.

Establishment

Some excellent stands of trefoils have been developed in certain moist pastures above the (app.) 1000-foot elevation in the Waimea, Kona, Kulani and Kahuku districts on the Island of Hawaii (figure 7). Trefoils do well in the reddish prairie soils, Latosolic brown forest soils, and Hydrol humic latosols. It takes one to two years to establish a good stand of trefoil because the seedlings are slow to develop. The plants are very persistent, however, once established.

A firm seedbed has been found to be much better than a loose one by several ranchers. To get a firm seedbed, roll the field with a roller or a cultipacker. In preparing a grass pasture for trefoil seeding, plow the land rather shallow to leave more of the grass roots and stems near the surface. These roots and stems will act as a mulch and make it possible for the soil to absorb more water. Do not cover the fine seeds too deeply; about $\frac{1}{8}$- to $\frac{1}{4}$-inch is ideal. One to two pounds of big trefoil, and two to three pounds of broadleaf trefoil seeds per acre, are sufficient to get a good stand. Whenever possible, crowding and competition from other more rapidly developing plants should be avoided to a minimum.

At the time of seeding, inoculate the seeds with trefoil inoculant bacteria to insure good nodulation. The bacteria are specific and do not cross inoculate; so when ordering inoculant specify the types of bacteria by stating "for big trefoil" or "for broadleaf trefoil". The big trefoil bacteria are different from those of the broadleaf trefoil. Some failures of establishing a stand of trefoil may be blamed on the lack of proper inoculation, without which the plants develop no nodules on the roots, turn yellow, and look weak when 2- to 3-inches high.

Trefoils are planted in mixtures with several kinds of grasses, such as paspalum (*Paspalum dilatatum*), kikuyu (*Pennisetum clandestinum*), rye (*Lolium* spp.), and pangola (*Digitaria decumbens*). When seeding trefoil in an established pasture, first graze the forage fairly close to the ground and then seed. Another method is to sprig in a small crown division by placing it in a hole. Some ranchers have been successful in establishing trefoils by this method.

Using many species in a mixture is a common practice that often makes management difficult. The idea of using a wide variety of species in a mixture to lengthen the grazing period is greatly overvalued. The more aggressive varieties, or those favored by the particular management system, generally increase to the disadvantage of others, thereby defeating the original purpose.

An experimental result in California showed that narrowleaf trefoil and broadleaf trefoil grown alone yielded 6.54 and 7.32 tons per acre, respectively (dry basis).

Grazing Management

The principal of grazing management is to have small paddocks with short rotational periods. Ranchers know that there is great wastage in feed when few animals are turned into a large paddock with abundant forage. To avoid such wastage, develop small areas that can be grazed in a few days to a few weeks, after which the animals can be moved on to the next paddock. Trampling and fouling by manure droppings are ways in which forage is wasted.

Do not graze trefoil too close to the ground. It has been found that 4-inch height grazing is better than 1-inch height grazing.

Insects and Diseases

At the present time trefoils are relatively free from insects and diseases. Hundreds of trefoils were examined by the writer in the various districts on all the islands and very few indications of either insect damage or disease were noticed.

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NOTES

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